Advancement of Eddy Current Based Evaluation of Axial Force of High-Strength Bolts

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Abstract

High-strength bolted joints are widely used in steel bridges. However, bolt axial force may decrease during the service life of a bridge for many reasons including relaxation, traffic load, and earthquake. Consequently, the remaining bolt axial force is considered a factor with uncertainty that is important to evaluate. In a previous study, the authors proposed an axial force evaluation method using eddy current. In this study, to apply the proposed axial force evaluation method to the actual measurements, new evaluation indices with the possibility of reducing measurement errors and simplifying measurement have been considered. The applicability of the improved method for high-strength bolts using weathering steel has also been examined. An experiment using both high-strength bolts and weathering steel high-strength bolts was conducted to investigate the possibility of evaluating the stress change due to the axial force with the new indices.

Keywords: bolted joint; high-strength bolt; axial force; eddy current; permeability; stress

1 Introduction

High-strength bolted joints are widely used in steel bridges since they improve construction efficiency during both construction and replacement [1]. However, the initially introduced axial force changes due to various reasons such as traffic vibration, corrosion, creep, and relaxation [2][3] and it is difficult to determine the amount of change that occurs. Therefore, the remaining bolt axial force can be considered a factor within a bridge in service that includes uncertainty, and is an important factor to evaluate for the long-term maintenance of steel bridges. In addition, since high-strength bolted joints are often arranged in multiple rows [4][5] and require a large number of bolts, a simple method is required to measure and evaluate the remaining bolt axial force.

In a previous study, the authors of this paper proposed an axial force evaluation method using eddy current [6]. The eddy current method [7] was found to have two advantages, namely, it can take measurements non-destructively, without contact, and it can be applied to measurement targets with defects or corrosion [8][9]. Moreover, it was shown in the previous study that the magnetostrictive effect, where internal magnetic properties change with changes in the stress of a steel member, also affects the eddy current flowing through steel members. The proposed axial force evaluation method evaluates the axial force by considering